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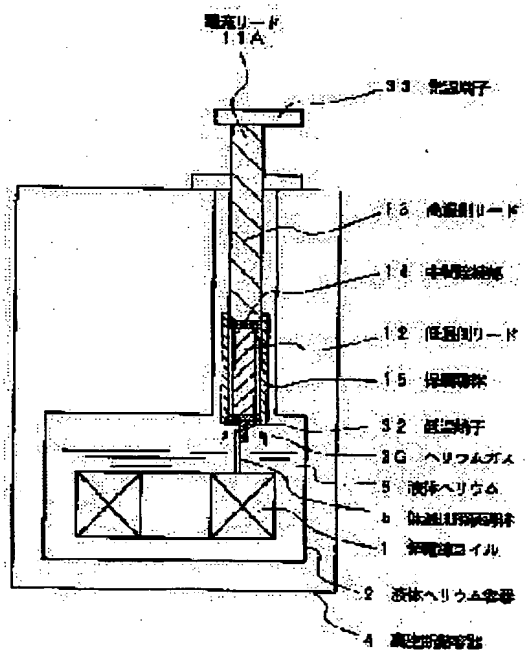
(54) CURRENT LEAD FOR SUPERCONDUCTING DEVICE

(57)Abstract:
PURPOSE: To prevent burning of a high temperature oxide superconductor due to abnormal temperature rise in current application by providing a protective conductor electrically connected to a low temperature side lead in parallel.
CONSTITUTION: A protective conductor 15 formed of metal material such as stainless steel, etc., is provided by electrically connecting to a low temperature side lead 12 in parallel. The protective conductor 15 is formed into a cylinder, and helium gas of low temperature is introduced into the inside of the protective conductor 15 through a communication channel provided to a low temperature terminal 32, and then made to flow to the high temperature side lead 13 through a communication channel provided to an intermediate connection part 14, so that a high temperature oxide superconductor constituting the low temperature side lead 12 and the protective conductor 15 are effectively cooled. Further, the protective conductor 15 consists of a series-connection-body wherein good- conduction metal made of copper, or copper alloy is provided on its both end parts, acting as electrical connection parts, and low-temperature-conduction metal made of stainless steel is assigned on the central part, for joint.



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CLAIMS

[Claim(s)]
[Claim 1] By the current lead for superconduction equipments which carries out conduction of the current to the superconduction coil immersed for which and contained by liquid helium in the liquid helium container of a vaccum insulated vessel from an external power In the thing consist of series connection objects of the elevated-temperature side lead which uses a right conductivity metal as a conductor, and the low temperature side lead which uses a high-temperature-oxidation object superconductor as a conductor, carry out conduction of the gaseous helium, and using said high-temperature-oxidation object superconductor as a superconducting state the protection by which electrical connection was carried out to said low temperature side lead at juxtaposition -- the current lead for superconduction equipments characterized by arranging the conductor.
[Claim 2] the current lead for superconduction equipments according to claim 1 -- setting -- said protection -- the current lead for superconduction equipments characterized by coming to form a conductor in tubed and allotting said low temperature side lead to the interior.
[Claim 3] the current lead for superconduction equipments according to claim 1 or 2 -- setting -- said protection -- the current lead for superconduction equipments characterized by a conductor coming to form in the front face of an electrical connection part the metal membrane which consists of a right conductivity metal.
[Claim 4] The current lead for superconduction equipments to which the right conductivity metal used for formation of said metal membrane is characterized by being either of the alloys of the alloy of gold or a golden alloy, silver, or silver, copper, or copper in the current lead for superconduction equipments according to claim 3.
[Claim 5] the current lead for superconduction equipments according to claim 1 to 4 -- setting -- said protection -- the current lead for superconduction equipments characterized by a conductor consisting of a series connection object of a low-fever conductivity metal and the right conductivity metal joined by the both ends.
[Claim 6] The current lead for superconduction equipments to which said low-fever conductivity metal is characterized by being either stainless steel or a titanium ingredient in the current lead for superconduction equipments according to claim 5.
[Claim 7] The current lead for superconduction equipments to which said good conductivity metal is characterized by being either of the alloys of copper or copper in the current lead for superconduction equipments according to claim 5.
[Claim 8] the current lead for superconduction equipments according to claim 1 to 7 -- setting -- said protection -- the current lead for superconduction equipments characterized by forming the conductor in the configuration which has flexibility.
[Claim 9] the current lead for superconduction equipments according to claim 1 -- setting -- said protection -- the current lead for superconduction equipments characterized by coming to lay a conductor under the interior of said low temperature side lead.
[Claim 10] the current lead for superconduction equipments according to claim 1 -- setting -- said protection -- the current lead for superconduction equipments characterized by coming to be allotted to the interior of a conductor and hollow tubing with said same low temperature side lead.
[Claim 11] the protection occupied to the cross section inside said hollow tubing in the current lead for superconduction equipments according to claim 10 -- the current lead for superconduction equipments characterized by coming to select the rate of the cross section of a conductor and a low temperature side lead to 85% or less 50% or more.
[Claim 12] the current lead for superconduction equipments according to claim 1 -- setting -- said protection -- the current lead for superconduction equipments characterized by coming densely to be allotted to the circulation way of gaseous helium where a conductor consists of pencil of lines of two or more conductive metallic conductors, and cools said low-temperature lead.
[Claim 13] the space where said low temperature side lead is formed in tubed, and touches the inside in the current lead for superconduction equipments according to claim 12 -- said protection -- the current lead for superconduction equipments characterized by coming to allot a conductor densely.
[Claim 14] the space between outside covering with which said low temperature side lead is formed in the

shape of a column, and is arranged in the current lead for superconduction equipments according to claim 12 on the outside, and a low temperature side lead -- said protection -- the current lead for superconduction equipments characterized by coming to allot a conductor densely.
[Claim 15] in the current lead for superconduction equipments according to claim 12, said low temperature side lead forms in the shape of a multiplex cylinder -- having -- the opening -- said protection -- the current lead for superconduction equipments characterized by coming to allot a conductor densely.
[Claim 16] the current lead for superconduction equipments according to claim 12 -- setting -- protection -- the current lead for superconduction equipments to which some of two or more conductive metallic conductors [at least] which form the aforementioned pencil of lines which make a conductor are characterized by coming to embed a metal system superconductor or a compound system superconductor inside.
[Claim 17] the current lead for superconduction equipments according to claim 12 to 16 -- setting -- protection -- the current lead for superconduction equipments characterized by said conductive metallic conductor which forms a conductor consisting of any one of bronze, a beryllium copper alloy, or nickel copper alloys.
[Claim 18] the low temperature side connection to which it has the energization current capacity which carries out conduction to said superconduction coil in the current lead for superconduction equipments according to claim 1 to 17, and the auxiliary current lead which uses a right conductivity metal as a conductor was attached, and the low-temperature terminal of each current lead was connected with said superconduction coil -- the current lead for superconduction equipments characterized by connecting with a conductor electrically.
[Claim 19] The current lead for superconduction equipments to which the attached auxiliary current lead is characterized by being the current lead constituted from a low-temperature terminal area by actuation in the room temperature section removable in the current lead for superconduction equipments according to claim 18.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the current lead for superconduction equipments which carries out conduction of the current to the superconduction coil in very low temperature from the power source in a room temperature, and the current lead for superconduction equipments which used the high-temperature-oxidation object superconductor for the low temperature side especially.
[0002]
[Description of the Prior Art] A superconduction coil needs to cool and use it by super-low hot-cold intermediation of liquid helium etc., and is contained in the condition of having been immersed in the liquid helium container usually prepared in the vaccum insulated vessel which prevented invasion of heat in liquid nitrogen shielding or a high vacuum layer at liquid helium. In order to be prepared in order that a current lead may carry out conduction of the exciting current to the superconduction coil held at very low temperature from the power source in the room temperature section, to stop joule generation of heat accompanying energization, and the heat which invades into a very-low-temperature side by heat conduction from an ordinary temperature side and to reduce the evaporation of liquid helium, usually constitutes so that the gaseous helium of the low temperature evaporated inside the current lead may be passed, it may cool and it may cool. Since the invasion heating value by heat conduction will increase if the cross-sectional area is enlarged and joule generation of heat is suppressed, and joule generation of heat will increase as a conductor of a current lead if the cross-sectional area is made small and the invasion heating value by heat conduction is stopped although right conductivity metals, such as copper or a copper alloy, are generally used, there is a limitation in the evaporation of the liquid helium which can be reduced. On the other hand, a high-temperature-oxidation object superconductor is arranged on the conductor of a low temperature side lead, and the current lead for superconduction equipments (for example, refer to JP,63-292610,A) connected and constituted in the elevated-temperature side lead and serial which use a right conductivity metal as a conductor attracts attention as what reduces the evaporation of liquid helium by leaps and bounds.
[0003] Drawing 14 is the sectional view having shown typically the superconduction equipment incorporating the conventional current lead for superconduction equipments. The superconduction coil 1 is contained in the condition of having been immersed in the liquid helium container 2 of a vaccum insulated vessel 4 at liquid helium-3, and is held at a superconducting state. the elevated-temperature side lead 13 with which a current lead 11 consists of right conductivity metallic conductors, such as copper or a copper alloy, and high-temperature-oxidation object superconduction -- the low-temperature side connection to which the low-temperature side lead 12 which consists of a conductor became from the series-connection object connected conductively by the middle connection 14, and a low-temperature terminal 32 was connected with a superconduction coil 1 -- a current is supplied to a superconduction coil 1 by being connected with a conductor 5 and connected with the power source which the ordinary-temperature terminal 33 does not illustrate. Moreover, a current lead 11 introduces gaseous helium 3G of the low temperature evaporated and evaporated with the liquid helium container 2 from the lower limit of the low temperature side lead 12, and is cooled.
[0004] the high-temperature-oxidation object superconduction of the low temperature side lead 12 -- as a conductor, if ceramic system high-temperature superconductors, such as an yttrium system and a bismuth system, are used, since it will be in a superconducting state below at liquid nitrogen temperature about, joule generation of heat becomes zero, and since these thermal conductivity of figures triple [2-] is also small compared with the case of copper, the invasion heat by conduction will also be reduced sharply. The bulk mold high-temperature-oxidation object superconductor which pressed and heat-treated high-temperature superconductivity material powder as a configuration in the case of applying as a conductor of the low temperature side lead 12, and the sheath mold high-temperature-oxidation object superconductor which pressed silver or its alloy as sheath material, and heat-treated it are known. Among these, although a sheath mold high-temperature-oxidation object superconductor has dozens times large critical current density and is more advantageous to miniaturization than a bulk mold high-temperature-oxidation object superconductor, since the thermal conductivity of the silver currently used as sheath material or its alloy is large, the description of the low-fever conductivity of a high-temperature-oxidation object superconductor cannot be employed efficiently. Therefore, it is common that a bulk mold high-temperature-oxidation object superconductor is used as a conductor of the low temperature side lead 12.

[0005]
[Problem(s) to be Solved by the Invention] In the current lead constituted as mentioned above, since joule generation of heat with a low temperature side lead becomes that there is nothing and thermal conductivity becomes minute [the invasion heat by conduction] very small, evaporation of the liquid helium by the current lead can be controlled in a minute amount, and superconduction equipment can be made very efficient.
[0006] However, when energizing in the connected superconduction coil also in the current lead constituted in this way, a certain cause -- the high-temperature-oxidation object superconduction of a low temperature side lead -- with 100 or more times of a metal, since the electric resistance in a normal conducting state is high if a conductor transfers from a superconducting state to a normal conducting state Great joule generation of heat is produced, the temperature of a conductor rises, and there is a danger of damaging by fire if an energization current is not attenuated in an instant.
[0007] On the other hand, with common superconduction equipment, as the basic block diagram of an excitation circuit was shown in drawing 15 , in the circuit which connects with a power source 23 and excites the superconduction coil 21 through the current leads 22 and 22A of a pair, protective resistance 24 is included in the superconduction coil 21 by juxtaposition. When the superconduction coil 21 produces the transition to a normal conducting state from a superconducting state according to a certain cause, damage on the superconduction coil 21 and a vaccum insulated vessel 26 is prevented by making the closed circuit which intercepts a switch 25 and consists of a superconduction coil 21 and protective resistance 24 form, and taking out the great magnetic energy accumulated in the excited superconduction coil 21 to the protective resistance 24 arranged into the room temperature part of the exterior of a vaccum insulated vessel 26.
[0008] therefore -- above -- the high-temperature-oxidation object superconduction of a low temperature side lead of a current lead -- when a conductor transfers from a superconducting state to a normal conducting state, even if it detects this and intercepts a switch 25, the current flowing, the current, i.e., the current lead, which flows the superconduction coil 21, will be decreased with the time constant which becomes settled in the inductance of the superconduction coil 21, and the resistance of protective resistance 24, and cannot perform momentary attenuation which carried out bearing protection of a current lead in mind. for this reason, high-temperature-oxidation object superconduction -- possibility that the temperature of a conductor will rise rapidly and will be damaged by fire becomes high. If a current lead is damaged by fire, since the closed circuit which consists of a superconduction coil 21 shown in drawing 15 and protective resistance 24 will be in the condition of having been wide opened in current leads 22 or 22A, it becomes impossible to take out the energy accumulated in the superconduction coil 21 to protective resistance 24, and the danger of producing damage in damage, the power sources 23, and vaccum insulated vessels 26 of the superconduction coil 21, such as dielectric breakdown, becomes high.
[0009] This invention is made in view of the above-mentioned trouble. That purpose In the current lead for superconduction equipments which consisted of series connection objects of the elevated-temperature side lead which uses a right conductivity metal as a conductor, and the low temperature side lead which uses a high-temperature-oxidation object superconductor as a conductor It is in offering the current lead for superconduction equipments which can be used for insurance, without preventing burning by abnormal temperature rise and producing damage in a superconduction coil, a power source, or a heat insulation vacuum housing, even if a high-temperature-oxidation object superconductor may transfer to a normal conducting state according to a certain cause at the time of energization.
[0010]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, it sets to this invention. (1) By the current lead for superconduction equipments which carries out conduction of the current to the superconduction coil contained in the condition of having been immersed in the liquid helium container of a vaccum insulated vessel at liquid helium from an external power In the thing consist of series connection objects of the elevated-temperature side lead which uses a right conductivity metal as a conductor, and the low temperature side lead which uses a high-temperature-oxidation object superconductor as a conductor, carry out conduction of the gaseous helium, and using a high-temperature-oxidation object superconductor as a superconducting state the protection by which electrical connection was carried out to the low temperature side lead at juxtaposition -- suppose that a conductor is arranged.
[0011] (2) the further above-mentioned protection -- a conductor is formed in tubed and suppose that a low temperature side lead is arranged to the interior.
(3) the further above-mentioned protection -- suppose that the metal membrane which consists of an alloy of the alloy of a right conductivity metal, for example, gold, or a golden alloy, silver, or silver, copper, or copper etc. is formed in the front face of the electrical connection part of a conductor.
[0012] (4) the further above-mentioned protection -- suppose that a conductor is formed as a series connection object of a low-fever conductivity metal like stainless steel or titanium, and a right conductivity metal, for example like copper or a copper alloy joined by the both ends.
(5) further -- these protection -- suppose that a conductor is formed in the configuration which has flexibility.

[0013] (6) (1) protection -- suppose that a conductor is laid under the interior of a low temperature side lead. [moreover,]
(7) (1) protection -- allotting a conductor and a low temperature side lead to the interior of the same hollow

tubing -- carrying out -- further -- protection -- suppose that it selects so that the rate of the cross section which a conductor and a low temperature side lead occupy inside hollow tubing may become 85% or less 50% or more. [or]
(8) (1) protection -- a conductor -- for example, bronze and a beryllium copper alloy -- [moreover,] Or it forms from the pencil of lines of two or more conductive metallic conductors which consist of a nickel copper alloy etc. the space which decides to allot densely the circulation way of the gaseous helium which cools a low-temperature lead, forms a low temperature side lead in tubed, and touches the inside -- protection -- whether a conductor is arranged densely or outside covering which forms a low temperature side lead in the shape of a column, and is arranged on the outside, a low temperature side lead, and space -- protection -- or it arranges a conductor densely -- or a low temperature side lead -- the shape of a multiplex cylinder -- forming -- the opening -- protection -- suppose that a conductor is arranged densely.
[0014] (9) Suppose that a metal system superconductor or a compound system superconductor is embedded to some [at least] interior of the conductive metallic conductor which forms the further above-mentioned pencil of lines.
(10) moreover, the low temperature side connection which attached the auxiliary current lead which uses a good conductivity metal as a conductor with the current capacity which carries out conduction to said superconduction coil, and connected the low-temperature terminal of these current leads with the superconduction coil at the above-mentioned current lead for superconduction equipments -- suppose that electrical connection is carried out to a conductor.
[0015] (11) Suppose further that the auxiliary current lead attached to the current lead for superconduction equipments is constituted from a low-temperature terminal area removable by actuation in the room temperature section like the above.
[0016]
[Function] the current lead for superconduction equipments -- the above (1) like -- protection -- the thing which electrical connection of the conductor is carried out [thing] to a low temperature side lead, and makes it arrange it in juxtaposition -- then the high-temperature-oxidation object superconduction of a low temperature side lead -- even if a conductor produces usual state electrical conduction transition -- high-temperature-oxidation object superconduction -- the protection to which parallel connection of the current which was flowing the conductor was carried out -- since it is bypassed by the conductor, the magnetic energy accumulated in the superconduction coil will be certainly consumed by the protective resistance installed outside. Therefore, it can consider as the current lead for superconduction equipments which can be used for insurance, without producing the damage on this configuration then a superconduction coil, a vaccum insulated vessel, etc.
[0017] furthermore, the above (2) like -- protection -- forming a conductor in tubed and arranging a low temperature side lead to the interior -- then the conduction hole of a low-temperature terminal -- letting it pass -- low-temperature helium -- protection -- leading to the interior of a conductor -- protection -- a conductor the function of guide tubing of the gaseous helium of the low temperature which it not only protects a low temperature side lead electrically, but cools a low temperature side lead to coincidence -- achieving -- further -- protection -- a conductor -- it is cooled more certainly [self] than a cylinder wall. therefore, the high-temperature-oxidation object superconduction of a low temperature side lead -- even if usual state electrical conduction transition arises temporarily [usual state electrical conduction transition of a conductor is suppressed, and] -- a current -- certain -- protection -- it will be bypassed by the conductor and a low temperature side lead will be protected.
[0018] furthermore, the above (3) like -- protection -- forming in the front face of the electrical connection part of a conductor the metal membrane which consists of an alloy of the alloy of a right conductivity metal, for example, gold, a golden alloy, silver, or silver, copper, or copper etc. -- then protection -- the case where it is formed with the metal in which conductivity is inferior like [when the conductor is formed with the metal of right conductivity / not to mention] stainless steel -- also setting -- protection -- electrical connection of the conductor can be easily carried out by pewter connection, and connection resistance can be suppressed very low. therefore, the protection by which parallel connection is carried out to a low temperature side lead -- since it becomes possible to suppress resistance of the circuit of a conductor to a low value -- the high-temperature-oxidation object superconduction of a low temperature side lead -- the time of a conductor producing usual state electrical conduction transition -- protection -- a high current will be bypassed to a conductor.
[0019] moreover, the above (4) like -- protection -- forming a conductor as a series connection object with a right conductivity metal, for example like copper joined to stainless steel and a low-fever conductivity metal like titanium by the both ends -- then the very low electrical connection of connection resistance having become possible, and having made the low-fever conductivity metal intervene by making pewter connection of the right conductivity metal -- little protection of the conduction heating value to the very-low-temperature section, since a conductor is obtained the time of steady operation -- the amount of heat invasion -- few -- high-temperature-oxidation object superconduction -- when a conductor produces usual state electrical conduction transition, a current will be bypassed effectively.
[0020] furthermore, the above (5) like -- protection -- forming a conductor in the configuration which has flexibility, then the high-temperature-oxidation object superconduction of a low temperature side lead -- the

protection which carried out parallel connection to a conductor and this -- the high-temperature-oxidation object superconduction in which reinforcement is relatively inferior since the added thermal stress will be eased even if a difference arises in the amount of heat shrinks according to the difference of a coefficient of thermal expansion with a conductor -- breakage of a conductor will be prevented.

[0021] moreover, the above (6) like -- protection -- laying a conductor under the interior of a low temperature side lead, then protection -- since a conductor touches a low temperature side lead not only over the upper limit section and the lower limit section but over the whole longitudinal direction and is connected electrically, it is very effective as a parallel connection object. furthermore, protection -- since the conductor and the low temperature side lead are formed in one -- protection -- as a conductor, if stainless steel is used, a role of an on-the-strength reinforcement member of a low temperature side lead will also be played in coincidence.

[0022] moreover, the above (7) like -- protection -- allotting a conductor and a low temperature side lead to the interior of the same hollow tubing, then introducing low-temperature gaseous helium inside this hollow tubing -- protection -- a conductor and a low temperature side lead will be cooled by coincidence. especially two or more protection -- a conductor and two or more high-temperature-oxidation object superconduction -- the low temperature side lead which consists of a conductor being built into the interior of hollow tubing, and, if the rate of the cross section occupied inside hollow tubing is selected so that it may become 50% or more of abbreviation protection, since a conductor and a low temperature side lead distribute to homogeneity mostly and are arranged inside hollow tubing the gaseous helium led to the interior of hollow tubing -- protection, if it selects so that it will flow, without inclining the opening of a conductor and a low temperature side lead and may become 85% or less of abbreviation about the rate of the above-mentioned cross section Since the opening of moderate passage remains inside hollow tubing, conduction of the gaseous helium can be carried out without producing excessive pressure loss. therefore, a low temperature side lead and protection -- since a conductor is efficiently cooled by a small amount of gaseous helium, the amount of heat invasion at the time of steady operation stops a little -- having -- moreover, high-temperature-oxidation object superconduction -- a current can be made to bypass effectively when a conductor produces usual state electrical conduction transition

[0023] moreover, the above (8) like -- protection -- a conductor -- for example, bronze and a beryllium copper alloy -- Or it forms from the pencil of lines of two or more conductive metallic conductors which consist of a nickel copper alloy etc. the space which decides to allot densely the circulation way of the gaseous helium which cools a low-temperature lead, for example, forms a low temperature side lead in tubed, and touches the inside -- protection -- whether a conductor is arranged densely or a low temperature side lead -- the shape of a column -- forming -- the space of the outside -- protection -- whether a conductor is arranged densely or a low temperature side lead -- the shape of a multiplex cylinder -- forming -- the opening -- protection -- arranging a conductor densely -- then being formed from much pencil of lines -- protection -- the surface area per cross section of a conductor becoming large, and being arranged densely on the circulation way of gaseous helium -- homogeneity -- and it will be cooled efficiently. therefore, the amount of heat invasion at the time of steady operation stops a little -- having -- moreover, high-temperature-oxidation object superconduction -- a current can be made bypassed effectively when a conductor produces usual state electrical conduction transition

[0024] furthermore, the above (9) like -- protection -- the part below embedding a metal system superconductor or a compound system superconductor to the interior of some [at least] conductors of the conductive metallic conductor which forms the pencil of lines of a conductor, then the critical temperature of the embedded superconductor -- protection -- a conductor will also be in a superconducting state. therefore -- even if the situation where the high-temperature-oxidation object superconductor which constitutes a low temperature side lead is damaged, and energization becomes impossible according to generating of the crack by the heat cycle etc. arises with prolonged use -- repair of a low temperature side lead -- not carrying out -- ** -- protection -- steady operation can be made to maintain through a conductor, and increase of invasion heat can be controlled.

[0025] moreover, the low temperature side connection with which the auxiliary current lead which uses a right conductivity metal as a conductor was attached to these current leads, and each low-temperature terminal was connected to them by the superconduction coil like the above (10) -- carrying out electrical connection to a conductor -- then high-temperature-oxidation object superconduction -- the connection by the side of the ordinary temperature connected with a power source when a conductor is damaged by fire and it becomes use impossible -- the ordinary temperature terminal of the ordinary temperature terminal of the current lead which damaged the conductor to an auxiliary current lead -- a bond frog -- re-excitation of a superconduction coil can be easily enabled by things.

[0026] furthermore, the auxiliary current lead attached like the above (11) -- a current lead removable at a low-temperature terminal area, then protection -- since the attached auxiliary current lead can be removed and used at the time of the usual energization actuation using the low temperature side lead which arranged the conductor, the invasion heating value by heat conduction in an auxiliary current lead can be made for there to be nothing. moreover, high-temperature-oxidation object superconduction -- the time of a conductor being damaged by fire and becoming use impossible -- an auxiliary current lead -- equipping -- the connection by the side of ordinary temperature -- a conductor -- a bond frog -- re-excitation of a

superconduction coil can be enabled by things.
[0027]
[Example] Hereafter, the example of this invention is explained based on a drawing. Drawing 1 is typical drawing of longitudinal section of the superconduction equipment incorporating the current lead for superconduction equipments by the 1st example of this invention. About the component part which has the same function as the already explained conventional example, the same sign is attached and the duplicate explanation is omitted.
[0028] the protection formed with metallic materials, such as stainless steel material, in this drawing -- electrical connection of the conductor 15 is carried out to juxtaposition, and it is arranged in it by the low temperature side lead 12. the high-temperature-oxidation object superconduction which constitutes the low temperature side lead 12 -- the current on which, as for a conductor, it flows current lead 11A by the superconducting state of normal operation since electric resistance is zero -- high-temperature-oxidation object superconduction -- a conductor -- flowing -- protection -- although it does not flow to a conductor 15 -- high-temperature-oxidation object superconduction -- if a conductor transfers to a normal conducting state -- high-temperature-oxidation object superconduction -- the current which flows current lead 11A since a conductor is the ceramics and presents the very high electrical resistivity near an insulator -- protection -- it will bypass to a conductor 15. therefore, high-temperature-oxidation object superconduction -- since taking out the magnetic energy which separated the superconduction coil 21 from the power source 23, and was stored in the superconduction coil 21 by intercepting a switch 25 with the transition to the normal conducting state of a conductor as already shown in drawing 15 to protective resistance 24, then the current which flows the low temperature side lead 12 in the meantime are zero mostly, equipment can be suspended safely, without producing an excessive temperature rise. in addition -- even if the low temperature side lead 12 is damaged -- magnetic energy -- protection -- equipment can be suspended safely, without damaging a superconduction coil, a power source, or a vaccum insulated vessel, since it is taken out by protective resistance through a conductor.
[0029] protection -- the thing concerning the protection method of the superconduction coil 21 with which a conductor 15 constitutes superconduction equipment like the above -- it is -- the ingredient, a dimension, etc. -- the resistance of the maximum stored energy of the superconduction coil 21, or protective resistance 24, the permission invasion heating value of the forward always of the low temperature side lead 12, or protection -- it is decided with the permissible maximum temperature of a conductor 15 etc. since electrical resistivity is small and copper or its alloy, aluminum, or its alloy can take high energization current density -- protection -- although the dimension as a conductor 15 is small and it ends, since thermal conductivity is high, these have a possibility that the invasion heating value of forward always may become excessive. Although it is effective, it is necessary to consider, if stainless steel material is used at the point at the point which controls an invasion heating value so that the temperature rise at the time of energization may not become excessive.
[0030] Low-temperature gaseous helium is led to the interior of a conductor 15. in addition, protection -- the conduction slot which formed the conductor 15 in tubed and was established in the low-temperature terminal 32 and which is not illustrated -- leading -- protection -- passing to the elevated-temperature side lead 13 through the conduction slot which was established in the middle connection 14 and which is not illustrated, then the high-temperature-oxidation object superconduction which constitutes the low temperature side lead 12 -- a conductor -- further -- protection -- a conductor 15 is cooled effectively and the invasion heating value at the time of steady operation is reduced effectively.
[0031] Drawing 2 is typical drawing of longitudinal section expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 2nd example of this invention. It is in the point that the conductor 15 equips the electrical connection with the metal membranes 17A and 17B which consist of a right conductivity metal. the protection in which the difference with the 1st example of this example was formed by stainless steel material -- the middle connection object 14 which consists metal membrane 17A of a right conductivity metal -- moreover, the thing for which pewter connection of the metal membrane 17B is made at the low-temperature terminal 32 which consists of a right conductivity metal -- high-temperature-oxidation object superconduction -- electrical connection is carried out so that it may become the low temperature side lead 12 and parallel connection which consist of a conductor. the protection formed by stainless steel material -- since pewter connection is very difficult in order to carry out direct electrical connection of the conductor 15 to the middle connection object 14 and the low-temperature terminal 32, it is necessary to perform welded connection. however, the high-temperature-oxidation object superconduction which constitutes the low temperature side lead 12 since ambient temperature will serve as an elevated temperature if welded connection is performed -- possibility that a conductor causes presentation change and a superconduction property falls sharply is very high. on the other hand, the protection which equipped the electrical connection with the metal membranes 17A and 17B which consist of a right conductivity metal beforehand like this example -- making pewter connection using a conductor 15, then high-temperature-oxidation object superconduction -- without spoiling the property of a conductor, connection resistance can be suppressed minutely and it can connect. in addition, the protection which consists of metallic materials, such as stainless steel material, -- as an approach of forming in the electrical connection of a conductor 15 the metal membranes 17A and 17B which consist of a right conductivity metal, a plating approach, vacuum deposition, the sputtering method, or a spraying process is used.

[0032] Drawing 3 is typical drawing of longitudinal section expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 3rd example of this invention. the description of this example -- protection -- a conductor -- it is in consisting of a series connection object which 15A arranged the right conductivity metals 18A and 18B which become the both ends which turn into an electrical connection from copper or a copper alloy, arranged the low-fever conductivity metal 19 which becomes a center section from stainless steel material etc., and joined. since electrical connection could be easily carried out to the middle connection object 14 and the low-temperature terminal 32 by pewter connection like the 2nd example since the right conductivity metals 18A and 18B were used for the electrical connection, and the low-fever conductivity metal 19 is arranged on the center section with this configuration -- protection -- a conductor -- the heating value which invades into the low-temperature section through 15A can be controlled effectively. In addition, junction between the dissimilar metals of the right conductivity metals 18A and 18B and the low-fever conductivity metal 19 can be performed comparatively easily by the friction welding method or the electric sticking-by pressure method.

[0033] Drawing 4 is typical drawing of longitudinal section expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 4th example of this invention. the description of this example -- protection -- a conductor -- 15B is consisting of stainless steel material holding the flexibility formed in the shape of bellows. Since each part of a current lead is cooled by low-temperature gaseous helium in case it is used including a current lead in superconduction equipment, a heat shrink is carried out corresponding to the coefficient of thermal expansion and the temperature cooled of a component. the low temperature side lead 12 and protection -- a conductor -- the high-temperature-oxidation object superconduction in which reinforcement is inferior when the difference of the amount of heat shrinks will arise, thermal stress will be done mutually and thermal stress becomes excessive according to the difference of a component between 15B -- there is a possibility that the low temperature side lead 12 which consists of a conductor may be damaged. the configuration of this example -- setting -- protection -- a conductor -- since it is constituted so that 15B may hold flexibility, even if a difference arises in the amount of heat shrinks, thermal stress is eased, and breakage of the low temperature side lead 12 like the above can be avoided. moreover, protection -- a conductor -- having formed 15B in the shape of bellows -- protection -- a conductor -- the effectiveness that the amount of heat invasion by heat conduction through 15B decreases more is also acquired. in addition, the protection which consists of stainless-steel material with this configuration -- a conductor -- although 15B illustrated the thing holding flexibility -- protection -- a conductor -- as shown in the thing which 15B becomes from a right conductivity metal, or the 3rd example, even if it consists of a series-connection object which joined the good conductivity metal and the low-fever conductivity metal, it is not necessary to illustrate that the configuration, then the same effectiveness held flexibility are acquired

[0034] Drawing 5 is the typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 5th example of this invention, and the sectional view of the low temperature side lead with which (a) is used for a whole sectional view and (b) is used for (a), and (c) are sectional views of other low temperature side leads used for (a). this example was shown in (b) -- as -- protection of the shape of the round bar made from stainless steel -- a conductor -- it was shown in 15C or (c) -- as -- protection of the shape of a cylinder made from stainless steel -- a conductor -- two or more high-temperature-oxidation object superconduction which laid 15D underground -- it is arranged in the interior of the hollow tubing 20, it is cooled by the gaseous helium introduced, and low temperature side lead 12A which consists of a conductor is held at a superconducting state. this configuration -- setting -- protection -- a conductor, since low temperature side lead 12A is electrically connected with 15C or 15D covering the overall length of the upper limit section and not only the lower limit section but a longitudinal direction since it is effective as a parallel connection object and is further formed in one -- essential -- weak high-temperature-oxidation object superconduction -- protection of the product [mechanical strength / of a conductor] made from stainless steel -- a conductor -- it is reinforced by 15C or 15D, and the mechanical damage of low temperature side lead 12A is prevented. moreover, protection of the shape of a cylinder shown in (c) -- a conductor -- the gaseous helium to which low temperature side lead 12A which laid 15D underground flows a periphery, and protection -- a conductor -- it will be effectively cooled by the gaseous helium which flows the interior of 15D.

[0035] Drawing 6 is the typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 6th example of this invention. this example -- setting -- the high-temperature-oxidation object superconduction of the bulk mold of the shape of two or more round bar -- protection of the shape of low temperature side lead 12B which consists of a conductor, and the round bar made from two or more stainless steel -- a conductor -- it is densely arranged in the interior of hollow tubing 20A, and connects electrically and mechanically at the both ends of a longitudinal direction, and 15E cools the opening inside hollow tubing 20A by the flowing gaseous helium, and is held and used for a superconducting state.

[0036] Drawing 7 is the typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 7th example of this invention. the difference with the 6th example of this example -- the high-temperature-oxidation object superconduction of the bulk mold of the shape of two or more round bar -- low temperature side lead 12B which consists of a conductor -

- replacing -- the high-temperature-oxidation object superconduction of the sheath mold of the shape of two or more round bar -- it is in the point that low temperature side lead 12C which consists of a conductor is used, and others are the same.

[0037] In the current lead for superconduction equipments by the 6th above-mentioned example and 7th above-mentioned example The rate of the total cross section of 15E is selected to 50% or more. low temperature side lead 12B (or 12C) occupied inside hollow tubing 20A, and protection -- a conductor -- low temperature side lead 12B (or 12C) by which the gaseous helium introduced was distributed by homogeneity, and protection -- a conductor -- it will distribute and flow to homogeneity mostly in the opening of 15E. Therefore, even when the flow rate of gaseous helium is little, the rate of flow will increase, a heat transfer rate will improve, and it will be cooled effectively.

[0038] Drawing 8 is the type section Fig. expanding and showing the basic configuration for a low-temperature flank of the current lead for superconduction equipments by the 8th example of this invention, (a) is drawing of longitudinal section and (b) is the cross-sectional view of an important section. In this configuration, an elevated-temperature side is set to middle connection 14A, and fitting of the low temperature side is carried out to low-temperature terminal 32B, and soldering connection of the low temperature side lead 12D formed in the shape of a cylinder is made so that (a) may see. the protection which the closure member 43 formed in the core inside low temperature side lead 12D by the airtight member is allotted, and becomes the space between the closure member 43 and the inside of low temperature side lead 12D from the nickel copper alloy of a book -- a conductor -- 15F are incorporated. protection -- a conductor -- the end of 15F -- the elevated-temperature side connection object 41 -- minding -- middle connection 14A -- moreover, the other end connects conductively to low-temperature terminal 32B through the low temperature side connection object 42 -- having -- **** -- protection -- a conductor -- 15F and low temperature side lead 12D constitute the parallel connection object electrically. moreover, the protection which consists of a nickel copper alloy of an a large number book so that (b) may see -- a conductor -- 15F It inserts in the space between the closure member 43 and the inside of low temperature side lead 12D densely. It is arranged, as illustrated to (a), it is introduced through the conduction hole prepared in low-temperature terminal 32B, and it is cooled by gaseous helium 3G sent to an elevated-temperature side lead through the conduction hole prepared in middle connection 14A, and invasion heat is removed. the protection occupied with this configuration to the cross section of the space between the closure member 43 and the inside of low temperature side lead 12D -- a conductor -- since the rate of the cross section of 15F has reached to 70% or more and gaseous helium 3G flow to homogeneity in each part -- protection -- a conductor -- 15F and low temperature side lead 12D will be cooled by homogeneity, and the conductive heat which invades into low-temperature terminal 32B through these will be reduced.

[0039] Drawing 9 is the typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 9th example of this invention. the protection which consists of a nickel copper alloy of a book in this example -- a conductor -- 15F are inserted and arranged densely in the space between low temperature side lead 12E formed in the shape of a cylinder, and the covering 44 of the periphery section. the protection by which parallel connection was carried out to low temperature side lead 12E like the 8th example also in this configuration -- a conductor -- 15F will be effectively cooled by gaseous helium and invasion heat will be reduced. moreover -- this configuration -- the periphery section of low temperature side lead 12E -- protection -- a conductor -- since covering 44 can be formed in arbitration after arranging 15F -- protection -- a conductor -- there is an advantage from which it becomes easy to insert and arrange 15F densely.

[0040] Drawing 10 is the typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 10th example of this invention. the 8th example above-mentioned in this example -- the same -- a gap with the closure member 43 inside cylinder-like low temperature side lead 12D -- protection -- a conductor -- 15G are allotted and it is constituted. the difference with the 8th example of this example -- protection -- a conductor -- are in the configuration of 15G and many nickel copper alloys of a book are used in the 8th example -- receiving -- this example -- metal system superconductor It is in the point that the nickel copper alloy of the a large number book with which the thin line of a Nb-Ti alloy was embedded is used. this configuration -- a low-temperature condition -- setting -- without it will repair low temperature side lead 12D even if it becomes the situation the high-temperature-oxidation object superconductor which constitutes low temperature side lead 12D deteriorates, and it becomes impossible energizing since a Nb-Ti alloy will be in a superconducting state -- this protection -- a conductor -- there is an advantage that steady energization is continuable through 15G.

[0041] In addition, it sets to this example and is a metal system superconductor to the nickel copper alloy of an a large number book. Although that where the Nb-Ti alloy was embedded was illustrated, equivalent effectiveness is acquired, even if many Nb-Ti alloys do not need to be embedded at all the nickel copper alloys of a book, balance energization current capacity and are embedded only at some nickel copper alloys. moreover, superconductor embedded it does not restrict to a Nb-Ti alloy -- Nb-Ti-Ta The same effectiveness will be acquired corresponding to the critical temperature of the superconductor, and energization capacity also as using compound system superconductors, such as metal system superconductors, such as an alloy, and Nb3Sn, Nb3aluminum.

[0042] Drawing 11 is the typical cross-sectional view expanding and showing a part for the low-temperature

flank of the current lead for superconduction equipments by the 11th example of this invention. the protection which becomes the gap and the innermost section of lead 12F from the nickel copper alloy of a book in this example the low temperature side formed in the shape of a duplex cylinder -- a conductor -- 15F are allotted densely and it is constituted. this configuration -- a low temperature side -- lead 12F and protection -- a conductor -- since the cross section of 15F can be taken greatly relatively, it is effective as an object for superconduction equipments for current leads with big energization current capacity.

[0043] in addition, the 8th - the 11th example which were shown in above-mentioned drawing 8 - drawing 11 - - setting -- protection -- although many nickel copper alloys of a book are used as a conductor, it does not restrict to a nickel copper alloy, and if it is conductive metallic conductors, such as bronze and a beryllium copper alloy, it is not necessary to illustrate that equivalent effectiveness is acquired Drawing 12 is typical drawing of longitudinal section of the superconduction equipment incorporating the current lead for superconduction equipments by the 12th example of this invention. from the elevated-temperature side lead 13 and the low temperature side lead 12 -- becoming -- protection -- the low temperature side connection to which the auxiliary current lead 16 which uses a right conductivity metal as a conductor is attached to current lead 11A which connected the conductor 15 with the low temperature side lead 12 electrically at juxtaposition, and each low-temperature terminal was connected with the superconduction coil 1 -- a conductor -- electrical connection is carried out to 5A. the high-temperature-oxidation object superconduction which constitutes the low temperature side lead 12 in this configuration -- the connection by the side of the ordinary temperature connected with a power source when a conductor is damaged by fire and it becomes use impossible -- ordinary temperature terminal 33A of the ordinary temperature terminal 33 of current lead 11A which damaged the conductor to the auxiliary current lead 16 -- a bond frog -- re-excitation of a superconduction coil is attained by things. the high-temperature-oxidation object superconduction which constitutes the low temperature side lead 12, in order to damage a conductor by fire, and for it to become impossible using it and to exchange these Although it is necessary for separation with the low-temperature terminal 32 under a very low temperature ambient atmosphere and a bond substitute to be needed, and to stop cooling of equipment for that purpose, to raise temperature, and to make the low-temperature terminal 32 into a room temperature and very uneconomical if the auxiliary current lead 16 is attached -- the connection by the side of ordinary temperature -- it can re-excite easily only by changing a conductor.

[0044] In addition, what is necessary is for there to be no joule generation of heat, and to pass a small amount of low-temperature gaseous helium, and just to cool it so that the minute part by heat conduction may be removed since the current is not flowing in this case although heat invades into the very-low-temperature section by heat conduction through the auxiliary current lead 16 also when current lead 11A is normally operated by having attached the auxiliary current lead 16.

[0045] Drawing 13 is typical drawing of longitudinal section of the superconduction equipment incorporating the current lead for superconduction equipments by the 13th example of this invention. In this example, the auxiliary current lead 16 attached to current lead 11A is incorporated by actuation in the room temperature section as removable using the removable low-temperature terminal 31. When [with much / when the superconduction coil 1 is large-scale and the superconduction coil 1 is accompanied by AC loss or when the amount of heat invasion of a vaccum insulated vessel 4 is large / evaporation of liquid helium] there are sufficiently many amounts of gaseous helium, the gaseous helium for cooling can be passed to the auxiliary current lead 16 by the 12th above-mentioned example, but when there are few amounts of heat invasion of superconduction equipment on the whole, it becomes difficult to secure the flow rate of the gaseous helium for cooling. The current lead for superconduction equipments by the 13th example shown in drawing 13 has few amounts of heat invasion of superconduction equipment in this way, and when reservation of a flow rate is difficult, it is suitable.

[0046] namely, the thing which the auxiliary current lead 16 inserts in the lower part in this example from the room temperature part corresponding to [in the part of the removable low-temperature terminal 31 of the low-temperature section, it is removable, and] the upper part of drawing -- the connection with a superconduction coil -- it can connect with a conductor and has composition which can be removed by pulling up to a upside room temperature part. In the service condition of normal, the auxiliary current lead 16 is taken as the condition of having removed to the exterior. In this condition, since there is no heat invasion in the very-low-temperature section by the auxiliary current lead 16, it is not necessary to pass the gaseous helium for cooling especially. other examples already described when the low temperature side lead 12 should have been damaged -- the same -- protection -- a current flows through a conductor 15 and superconduction equipment is suspended by insurance. the case where the low temperature side lead 12 is use impossible -- the auxiliary current lead 16 -- inserting -- the removable low-temperature terminal 31 -- equipping -- the connection by the side of ordinary temperature -- a conductor -- ordinary temperature terminal 33A -- a bond frog -- things enable it to excite again. in addition, the protection which carries out parallel connection to the low-temperature side lead 12 of current lead 11A and which is included in it in the example shown in drawing 12 and drawing 13 -- as a conductor -- protection of the 1st example of drawing 1 -- the protection shown in the 2nd - the 11th example which were shown in drawing 2 - drawing 11 , respectively although the conductor 15 had been illustrated -- even if it uses a conductor, it is not necessary to explain anew that the same effectiveness as the above is acquired, and it is clear.

[0047]

[Effect of the Invention] It sets to this invention and is (1) as mentioned above. The current lead for superconduction equipments which carries out conduction of the current to the superconduction coil contained in the condition of having been immersed in the liquid helium container of a vaccum insulated vessel at liquid helium from an external power In what consists of series connection objects of the elevated-temperature side lead which uses a right conductivity metal as a conductor, and the low temperature side lead which uses a high-temperature-oxidation object superconductor as a conductor, carries out conduction of the gaseous helium, makes a superconducting state said high-temperature-oxidation object superconductor, and uses it protection, since electrical connection of the conductor is carried out to a low temperature side lead and it is made to arrange it in juxtaposition the high-temperature-oxidation object superconduction of a low temperature side lead -- whether a conductor produces usual state electrical conduction transition or results in breakage -- high-temperature-oxidation object superconduction -- the protection to which parallel connection of the current which was flowing the conductor was carried out, since it bypasses and flows to a conductor The current lead for superconduction equipments which can be used for insurance will be obtained without consuming certainly the magnetic energy accumulated in the superconduction coil by protective resistance, and producing the damage on a superconduction coil, a power source, a vaccum insulated vessel, etc.

[0048] (2) further -- protection -- forming a conductor in tubed and arranging a low temperature side lead to the interior, then protection -- it a conductor not only protects a low temperature side lead electrically, but achieves the function of guide tubing of the gaseous helium of the low temperature which cools a low temperature side lead to coincidence. therefore, the high-temperature-oxidation object superconduction of a low temperature side lead -- even if usual state electrical conduction transition arises temporarily [usual state electrical conduction transition of a conductor is suppressed, and] -- a current -- certain -- protection -- since it will be bypassed by the conductor and a low temperature side lead will be protected, it is suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0049] (3) further -- protection -- forming in the front face of the electrical connection part of a conductor the metal membrane which consists of an alloy of the alloy of a right conductivity metal, for example, gold, a golden alloy, silver, or silver, copper, or copper etc., then protection -- since electrical connection of the conductor can be easily carried out by pewter connection -- the high-temperature-oxidation object superconduction of a low temperature side lead -- connection resistance can be suppressed very low, without spoiling the property of a conductor. therefore, the protection by which parallel connection is carried out to a low temperature side lead -- resistance of the circuit of a conductor holds down to a predetermined value certainly -- having -- the high-temperature-oxidation object superconduction of a low temperature side lead -- even if a conductor produces usual state electrical conduction transition -- protection -- since a high current will be bypassed to a conductor, it is suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0050] (4) moreover, protection -- forming a conductor as a series connection object with a right conductivity metal, for example like copper joined to a low-fever conductivity metal like stainless steel by the both ends -- then the very low electrical connection of connection resistance having become possible, and having made the low-fever conductivity metal intervene by making pewter connection of the right conductivity metal -- little protection of the conduction heating value to the very-low-temperature section, since a conductor is obtained the time of steady operation -- the amount of heat invasion -- few -- the high-temperature-oxidation object superconduction of a low temperature side lead -- since a current is effectively bypassed when a conductor produces usual state electrical conduction transition, it is still more suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0051] (5) further -- protection -- forming a conductor in the configuration which has flexibility -- then the high-temperature-oxidation object superconduction of a low temperature side lead -- the protection which carried out parallel connection to a conductor and this -- the high-temperature-oxidation object superconduction in which the added thermal stress is eased and reinforcement is relatively inferior even if a difference arises in the amount of heat shrinks according to the difference of a coefficient of thermal expansion with a conductor, since breakage of a conductor is prevented It is still more suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0052] (6) moreover, protection -- laying a conductor under the interior of a low temperature side lead, then protection, since a conductor is electrically connected in contact with a low temperature side lead over the whole longitudinal direction as a parallel connection object -- very -- effective -- further -- protection -- since a conductor and a low temperature side lead are formed in one -- protection -- since a conductor reinforces the reinforcement of a low temperature side lead and prevents damage, it is suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0053] (7) moreover, protection -- allotting a conductor and a low temperature side lead to the interior of the same hollow tubing -- then A conductor and a low temperature side lead will be cooled by coincidence. introducing low-temperature gaseous helium inside this hollow tubing -- protection -- especially -- protection, if the rate of the cross section which a conductor and a low temperature side lead occupy inside hollow tubing

is selected so that it may become 85% or less 50% or more a low temperature side lead cools effectively, without producing excessive pressure loss -- having -- the flow rate of gaseous helium -- small quantity -- even when -- high-temperature-oxidation object superconduction -- a conductor will be held at a superconducting state and the amount of heat invasion at the time of steady operation will be controlled minutely. Therefore, it is more suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0054] (8) Form a conductor from the pencil of lines of two or more conductive metallic conductors which consist of a nickel copper alloy etc. moreover, protection -- the space which decides to allot densely the circulation way of the gaseous helium which cools a low-temperature lead, for example, forms a low temperature side lead in tubed, and touches the inside -- protection -- whether a conductor is arranged densely or a low temperature side lead -- the shape of a column -- forming -- the space of the outside -- protection -- whether a conductor is arranged densely or a low temperature side lead -- the shape of a multiplex cylinder -- forming -- the opening -- protection -- arranging a conductor densely, then protection -- a conductor -- homogeneity -- and it will be cooled efficiently and the amount of heat invasion at the time of steady operation will be stopped a little. Therefore, it is suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0055] (9) further -- protection -- embedding a metal system superconductor or a compound system superconductor to the interior of some [at least] conductors of the conductive metallic conductor which forms the pencil of lines of a conductor -- then even if the situation where the high-temperature-oxidation object superconductor which constitutes a low temperature side lead is damaged with prolonged use, and energization becomes impossible arises -- protection, since steady operation can be made maintained through a conductor As a current lead for superconduction equipments which can be used for insurance, it is more suitable, without damaging superconduction equipment.

[0056] (10) moreover -- above -- a low temperature side lead -- protection -- to the current lead which arranged the conductor the low temperature side connection which attached the auxiliary current lead which uses a right conductivity metal as a conductor, and connected each low-temperature terminal with the superconduction coil -- carrying out electrical connection to a conductor -- then high-temperature-oxidation object superconduction, even if it is, when a conductor is damaged by fire and a low temperature side lead becomes use impossible the connection by the side of the ordinary temperature connected with a power source -- the ordinary temperature terminal of the ordinary temperature terminal of the current lead which damaged the conductor to an auxiliary current lead -- a bond frog -- by things, since re-excitation of a superconduction coil can be easily performed now It is still more suitable as a current lead for superconduction equipments which can be used for insurance, without damaging superconduction equipment.

[0057] (11) -- the auxiliary current lead which the above attaches further -- a current lead removable at a low-temperature terminal area, then protection, since the attached auxiliary current lead can be removed and used while the low temperature side lead which arranged the conductor is operating normally [when a conductor is damaged by fire and it becomes use impossible] there is nothing about the invasion heating value by heat conduction in an auxiliary current lead -- carrying out -- the engine performance of the current lead of low-fever invasion -- securing -- and high-temperature-oxidation object superconduction -- an auxiliary current lead -- equipping -- the connection by the side of ordinary temperature -- a conductor -- a bond frog -- it is still more suitable as a current lead for superconduction equipments which can be used for insurance by things, without damaging superconduction equipment since re-excitation of a superconduction coil can be easily performed now.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Typical drawing of longitudinal section of the superconduction equipment incorporating the current lead for superconduction equipments by the 1st example of this invention
[Drawing 2] Typical drawing of longitudinal section expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 2nd example of this invention
[Drawing 3] Typical drawing of longitudinal section expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 3rd example of this invention
[Drawing 4] Typical drawing of longitudinal section expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 4th example of this invention
[Drawing 5] (c) is the sectional view of the low temperature side lead which uses (a) for a whole sectional view and uses (b) for (a) with the typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 5th example of this invention, and a sectional view of other low temperature side leads used for (a).
[Drawing 6] The typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 6th example of this invention
[Drawing 7] The typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 7th example of this invention
[Drawing 8] In the type section Fig. expanding and showing the basic configuration for a low-temperature flank of the current lead for superconduction equipments by the 8th example of this invention, (a) is drawing of longitudinal section and (b) is the cross-sectional view of an important section.
[Drawing 9] The typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 9th example of this invention
[Drawing 10] The typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 10th example of this invention
[Drawing 11] The typical cross-sectional view expanding and showing a part for the low-temperature flank of the current lead for superconduction equipments by the 11th example of this invention
[Drawing 12] The typical sectional view of the superconduction equipment incorporating the current lead for superconduction equipments by the 12th example of this invention
[Drawing 13] The typical sectional view of the superconduction equipment incorporating the current lead for superconduction equipments by the 13th example of this invention
[Drawing 14] The typical sectional view of the superconduction equipment incorporating the conventional current lead for superconduction equipments
[Drawing 15] The basic block diagram of the excitation circuit of common superconduction equipment
[Description of Notations]
1 Superconduction Coil
2 Liquid Helium Container
3 Liquid Helium
3G Gaseous helium
4 Vaccum Insulated Vessel
5, 5A, and 5B low temperature side connection -- conductor
11 11A Current lead
12 12A Low temperature side lead
12B, 12C Low temperature side lead
12D, 12E Low temperature side lead
12F Low temperature side lead
13 Elevated-Temperature Side Lead
14 14A Middle connection
15 and 15A protection -- conductor
15B and 15C protection -- conductor
15D and 15E protection -- conductor
15F and 15G protection -- conductor
16 Auxiliary Current Lead
17A, 17B Metal membrane

18A, 18B Good conductivity metal
19 Low-Fever Conductivity Metal
20 20A Hollow tubing
31 Removable Low-temperature Terminal
32 32A Low-temperature terminal
32B Low-temperature terminal
33 33A Ordinary temperature terminal
41 Elevated-Temperature Side Connection Object
42 Low Temperature Side Connection Object
43 Closure Member
44 Covering

[Translation done.]